

ORIGINAL

BEFORE THE
Federal Communications Commission
WASHINGTON, D.C. 20554

In the Matter of)

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Rulemaking to Amend Parts, 1, 2,
21, and 25 of the Commission's Rules
to Redesignate the 27.5 - 29.5 GHz
Frequency Band, to Reallocate the
29.5 - 30.0 GHz Frequency Band, to
Establish Rules and Policies for
Local Multipoint Distribution Service
and For Fixed Satellite Services)

CC Docket No. 92-297

and)

Suite 12 Group Petition for Pioneer's
Preference)

PP-22

To: The Commission

REPLY COMMENTS OF TRW INC.

Norman P. Leventhal
Raul R. Rodriguez
Stephen D. Baruch
Bernard A. Solnik
Walter P. Jacob

Leventhal, Senter & Lerman
2000 K Street, N.W.
Suite 600
Washington, DC 20006-1809
202-429-8970

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Attorneys for TRW Inc.

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TABLE OF CONTENTS

	PAGE
SUMMARY	i-ii
INTRODUCTION	2
DISCUSSION	9
I. TWO NGSO MSS FEEDER LINK SYSTEMS CAN SHARE SPECTRUM IN THE 29.1 - 29.5 GHZ BAND	9
II. THE COMMISSION SHOULD ADOPT TRW'S MODEST PROPOSALS TO GOVERN CO-FREQUENCY SHARING BETWEEN NGSO MSS FEEDER LINKS AND GSO/FSS SYSTEMS	13
A. Motorola's Proposal To Ban Completely GSO/FSS Use Of The Shared Spectrum Near NGSO MSS Feeder Link Complexes Is Unnecessary	16
B. Hughes's And GE Americom's Suggestions That The Commission Require NGSO MSS Operators To Switch Satellites Or Earth Stations To Avoid Interference Or Change The 28 GHz Band Allocations Are Inequitable And Unnecessary	17
C. The Concerns Of Potential GSO/FSS Operators About Procedures For Coordination With NGSO MSS Feeder Link Systems Are Unfounded	21
D. Teledesic's Proposal To Allocate The 18.30-18.55 GHz Band Solely For Possible NGSO/FSS Use Is Outweighed By The Benefits Of Using That Band For GSO/FSS Downlinks	22
III. THE COMMISSION SHOULD REDUCE THE SHARING BURDEN ON THE LMDS ONLY TO THE EXTENT PROPOSED BY TRW	24
IV. THE COMMISSION'S PROPOSAL TO ACCOMMODATE THE 28 GHZ BAND REQUIREMENTS OF POINT-TO-POINT SERVICE OPERATORS UNDER THE LMDS UMBRELLA IS NEITHER ARBITRARY NOR CAPRICIOUS	27
V. NGSO MSS FEEDER LINK SPECTRUM SHOULD NOT BE ASSIGNED BY AUCTION, REGARDLESS OF WHETHER GSO/FSS SPECTRUM IS ASSIGNED BY AUCTION	32
VI. THE COMMISSION SHOULD NOT ACT PRECIPITOUSLY IN ALLOCATING PRECIOUS SPECTRUM FOR THE NGSO/FSS.	36
CONCLUSION	38

SUMMARY

No commenter other than TRW has provided detailed, realistic suggestions to enable the 28 GHz band to accommodate LMDS, GSO/FSS and two NGSO MSS feeder link systems with only modest burdens imposed on each system and without unduly favoring one class of service at the expense of the others.

For example, Motorola seeks to entirely avoid sharing with any other NGSO MSS feeder link system, but fails to discredit the analyses which conclude that such sharing is feasible. Motorola also proposes an overbroad restriction on GSO/FSS operations in the spectrum shared with NGSO MSS feeder links. Hughes proposes to avoid sharing by implementing unrealistic restrictions on the NGSO MSS and by rearranging the Commission's allocation plan so that GSO/FSS would not be subject to even the modest sharing criteria proposed by TRW. Hughes's contention that the proposed first-come-first-served rule could leave no room in the 29.25-29.50 GHz band for GSO/FSS systems also is meritless, since GSO/FSS and NGSO MSS feeder link systems can share spectrum and only two NGSO MSS systems would operate in the shared sub-band.

Teledesic proposes that the Commission overcrowd the 19.3-19.7 GHz band with NGSO MSS feeder link uplinks and downlinks and GSO/FSS downlinks so that 500 MHz of uplink spectrum and 750 MHz of downlink spectrum can be allocated for Teledesic's system on an exclusive basis. Teledesic clearly does not demonstrate why such an extensive, exclusive allocation is necessary.

Several LMDS proponents that are dissatisfied with having to share a small portion of spectrum with NGSO MSS feeder links contend that the Commission's

proposal to substantially limit the NGSO MSS feeder link systems in the 28 GHz band in order to facilitate sharing with the LMDS is not enough. Even though TRW has shown how to further reduce the amount of spectrum that LMDS systems would share with two NGSO MSS systems, these LMDS proponents propose to further reduce the modest sharing burden on the LMDS by imposing substantial and possibly prohibitive restrictions on the design and operation of NGSO MSS systems in the shared sub-band. Such suggestions are inequitable and contrary to the spirit of compromise inherent in the Commission's proposal.

Proponents of the terrestrial point-to-point service seek a greater allocation in the 28 GHz band specifically for this service, but concede that LMDS, GSO/FSS and NGSO MSS are as important as terrestrial point-to-point service. Thus, the terrestrial point-to-point proponents are unable to provide a single reason why such an allocation would advance the public interest.

With respect to competitive bidding, Hughes suggests that because GSO/FSS and NGSO MSS feeder link systems may operate in the same sub-band, these NGSO MSS feeder link systems are not exempt from the potential for competitive bidding to which GSO/FSS applicants may be subject. NGSO MSS and GSO/FSS are different services, which the Commission may subject to different rules, including different spectrum assignment procedures.

In sum, the Commission should adopt TRW's approach to facilitate and enhance the plan proposed in the Third NPRM and should reject others' self-serving suggestions that would, overall, harm more than help the Commission's efforts to accommodate LMDS and satellite services in the 28 GHz band.

92-0105

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To: The Commission

REPLY COMMENTS OF TRW INC.

TRW Inc. ("TRW"), by its attorneys and pursuant to Section 1.415 of the Commission's rules, hereby replies to comments filed in response to the Commission's Third Notice of Proposed Rulemaking and Supplemental Tentative Decision, CC Docket No. 92-297, FCC 95-287 (released July 28, 1995) ("Third NPRM"), in the above-captioned proceeding.

INTRODUCTION

In the Third NPRM, the Commission proposed to facilitate implementation of four radio services -- local multipoint distribution service ("LMDS"), non-geostationary and geostationary fixed satellite service ("NGSO/FSS" and "GSO/FSS," respectively), and non-geostationary mobile satellite service ("NGSO MSS" or "MSS") feeder links -- by allocating blocks of spectrum for each service in the 27.5-30.0 GHz band (the "28 GHz band").^{1/} To provide each service with enough 28 GHz band spectrum to support commercially viable systems, the Commission proposed that NGSO MSS feeder links share a portion of 28 GHz spectrum on a co-primary basis with LMDS at 29.1-29.25 GHz and with GSO/FSS at 29.25-29.50 GHz.

Most parties who filed comments recognized that such sharing would require some form of restriction on the operations of one or more of the systems in the shared spectrum to avoid harmful interference. However, only TRW offered practical techniques and clarifications to the Commission's proposal that could fully implement the sharing envisioned by the Commission at 29.1-29.5 GHz. TRW's approach would impose only modest constraints that would be fairly distributed among the NGSO MSS, GSO/FSS and LMDS systems in the 29.1-29.25 GHz and 29.25-29.5 GHz sub-bands, and would not have a significant impact on the provision of services to any user community. The Commission's proposal, if clarified in the manner suggested by TRW, would enable the 28 GHz band to be used by the two NGSO MSS systems with

^{1/} For the satellite services, the Commission also discussed and made proposals and suggestions concerning the co-directional paired frequency band at 17.7-20.2 GHz (the "19 GHz band").

longstanding requests to use the band for feeder links, and at the same time, allow meaningful operation by both LMDS and multiple GSO/FSS systems throughout the U.S.^{2/}

Despite the fact that their interests were expressly considered and deemed satisfied by the Commission during the formulation of the plan presented in the Third NPRM, while TRW's interests were misunderstood, other commenters from the LMDS, NGSO/FSS, GSO/FSS and even the NGSO MSS camps all are less willing to accept the Commission's proposed band plan than TRW. Motorola Satellite Communications, Inc. and Iridium, Inc. (collectively "Motorola"), for example, express uncertainty as to whether two NGSO MSS feeder link systems could share the 200 MHz of spectrum in the 29.1-29.3 GHz band.^{3/} Hughes Communications, Inc. ("Hughes") and Teledesic Corp. ("Teledesic"), both of which were prime beneficiaries of the compromise struck in the Third NPRM, also take substantive issue with the Commission's proposal. Several LMDS proponents, apparently unsatisfied with the fact that they are poised to gain exclusive, nationwide access to 850 MHz of spectrum (at 27.5-28.35 GHz) and unfettered access to an additional 150 MHz in all but eight mostly medium or small markets, have asked the Commission to relax proposed constraints on LMDS that most LMDS proponents agreed to just last year, and to impose additional restrictions on NGSO MSS systems. The Commission should reject all of these contrary views.

^{2/} Comments of TRW at 15-31.

^{3/} Comments of Motorola at 9-10.

Motorola, with its professed "uncertainty" as to co-frequency sharing between NGSO MSS feeder link systems, is apparently seeking an exclusive assignment at 29.1-29.3 GHz. Its claimed protection criteria are unsupported and conflict with both the international work done in preparation for the 1995 World Radiocommunication Conference ("WRC-95"), and with submissions of TRW.

Hughes, offering a strained interpretation of the term "sharing," unrealistically proposed to have the Commission avoid interference between NGSO MSS and GSO/FSS systems by either (1) requiring the NGSO MSS systems to switch satellites or earth stations every time interference might occur or (2) completely restructuring the Commission's band segmentation plan so that GSO/FSS and NGSO MSS are not assigned spectrum in the same sub bands.^{4/} Either alternative would impose substantial burdens on NGSO MSS (and LMDS) systems in the 28 GHz band that are wholly unnecessary, given the fact that GSO/FSS systems would bear an insignificant burden, if any at all, if the sharing techniques specified by TRW are implemented.

Teledesic proposes that all GSO/FSS systems operating at 29.25-29.50 GHz use the 19.3-19.7 GHz band for downlinks so that the 18.3-18.55 GHz band is available as the paired downlink band for NGSO FSS gateway and gigalink terminals that might operate on a secondary basis in the 27.5-28.35 GHz band.^{5/} In other words,

^{4/} Comments of Hughes at 18-26. GE American Communications, Inc. ("GE Americom") supports similar proposals. See Comments of GE Americom at 13-16.

^{5/} Comments of Teledesic at ii, 7-8. Although the Commission views Teledesic
(continued...)

Teledesic would have the Commission allocate 500 MHz of 28 GHz band spectrum on an exclusive basis to NGSO/FSS system uplinks, and 750 MHz of spectrum in the 19 GHz band for exclusive use by NGSO/FSS downlinks. Under Teledesic's proposal, the 19.3-19.7 GHz band also would support NGSO MSS feeder link downlinks and uplinks (the latter on a reverse-band basis).^{6/} Teledesic offered no explanation why future NGSO/FSS gateway and gigalink terminals and GSO/FSS systems should not or could not share the 18.3-18.55 GHz band so that overcongestion at 19.3-19.7 GHz is avoided. Furthermore, the Commission should reconsider its tentative determination to allocate 500 MHz of desirable 28 GHz band spectrum to accommodate a single system that is utterly incapable of sharing spectrum with any other system or service, especially since the fundamental feasibility of Teledesic's system is itself questionable.^{7/}

^{5/}(...continued)

as an NGSO/FSS system, Teledesic views its system as a hybrid NGSO FSS/MSS system. Compare Third NPRM, FCC 95-287, slip op. at ¶¶ 23-24; Comments of Teledesic at 1. Thus, while Teledesic proposes that the 18.3-18.55 GHz band be reserved for "NGSO satellite systems like Teledesic," it does not specify its apparent intention that the band be reserved particularly for the NGSO/FSS. Comments of Teledesic at 7-8.

^{6/} Comments of Teledesic at 7-8.

^{7/} On this last point, TRW believes that the Commission should be hesitant to make an allocation to the NGSO/FSS until the feasibility and public interest benefits of the grant of an authorization to the single pending NGSO/FSS applicant have been established.

Other parties contend that GSO/FSS systems require more than 1000 MHz of 28 GHz band spectrum.^{8/} However, none of these parties submitted technical support for this position. Indeed, several GSO/FSS proponents have indicated that 1000 MHz of 28 GHz spectrum is adequate to operate commercially viable GSO/FSS systems.^{9/} Equally important from TRW's perspective, no party has suggested that NGSO MSS be relegated to another band in order to increase the spectrum allocation for GSO/FSS. Rather, several parties note that the best solution would be to move LMDS to the 40 GHz band.^{10/} This is consistent with TRW's view that the Commission failed to provide a rational basis for its tentative conclusion that locating LMDS at 40.5-42.5 GHz is not feasible.^{11/}

While no party challenges the feasibility of LMDS sharing spectrum with NGSO MSS, some LMDS proponents complain that the Commission's proposal for sharing the 29.1-29.25 GHz band imposes too many restrictions on the LMDS (e.g., the ban on LMDS subscriber-to-hub transmissions in the 29.1-29.25 GHz band and other technical limitations on LMDS transmissions previously agreed to by LMDS

^{8/} See Comments of Loral Aerospace Holdings, Inc. at 2-4; Comments of NASA at 5-7.

^{9/} See Comments of GE Americom at 5-6; Comments of Hughes at i; Comments of Orion Network Systems, Inc. at 2-3.

^{10/} See, e.g. Comments of NASA at 24; Comments of GE Americom at 18-19; Comments of Lockheed Martin Corp. at 2-3

^{11/} Comments of TRW at 35.

proponents).^{12/} The only compromise that some LMDS proponents seem able to accept is one where they get everything they asked for and the other guy gets whatever scraps may be left. The unabashedly self-serving alternatives suggested by LMDS proponents would unnecessarily or unfairly burden NGSO MSS operations without providing any corresponding public interest benefit.^{13/} It is incumbent on the Commission not to allow self-serving interests to undermine services that can provide substantial public benefits -- such as the NGSO MSS.

^{12/} See Comments of Hewlett-Packard Co.; Comments of Texas Instruments Inc.; Comments of ComTech Associates, Inc.; Comments of Endgate Corp.; Comments of Northern Telecom Inc. ("Nortel"); Comments of CellularVision; Comments of GHz Equipment Co., Inc.; Comments of BellSouth; Comments of M3 Illinois Telecommunications Corp. ("M3"); Joint Comments of the Association of America's Public Television Stations ("APTS") and Public Broadcasting Service ("PBS").

^{13/} Several parties recognize that commercially viable LMDS systems can share spectrum with FSS systems, operate in less spectrum than proposed by the Commission, or operate in the 40 GHz band. See Comments of CellularVision at 4-5; Comments of Bell Atlantic Corp. at 3; Comments of Endgate Corp. at 4; Comments of Entertainment Made Convenient International, Inc. at 6; Comments of The Wireless Cable Ass'n International, Inc. at 5-6; Comments of GTE at 4; Comments of Duncan, Weinberg, Miller & Pembroke, P.C. at 2 (¶ 4); Comments of NASA at 9-13; Comments of GHz Equipment Co., Inc. at 3; Comments of GE Americom at 18-19. Some parties anticipate that LMDS may be able to use the 40 GHz band in the future. See Comments of Pacific Telesis Wireless Broadband Services at 2; Comments of CellularVision at 5-6 (for specialized terrestrial service); Comments of Comtech Associates, Inc. at 2 (¶ 2) (for specialized terrestrial service). Thus, if the Commission were unable to expeditiously finalize an equitable set of principles for sharing between NGSO MSS and LMDS systems, the Commission has other viable options to pursue.

Proponents of the terrestrial point-to-point service contend that the Commission's proposal "arbitrarily and capriciously" limits their access to the 28 GHz band. Contradicting their own position, however, these proponents acknowledge that the LMDS and satellite services to be accommodated in the 28 GHz band are at least as important to the public as terrestrial point-to-point service.

On the issue of competitive bidding, no commenter questioned the Commission's tentative conclusion that auctioning NGSO MSS feeder link spectrum would impose detrimental delays and costs without providing significant offsetting public benefits such as promoting efficient and intensive use of the spectrum. Nevertheless, Hughes argues that NGSO MSS feeder links should not necessarily be exempted from the competitive bidding to which GSO/FSS applicants may be subject.^{14/} Among other things, this argument misconstrues the fact that NGSO MSS and GSO/FSS are clearly different services, and the Commission need not apply the same spectrum assignment procedures to different services -- even if they are to use the same spectrum.

Inasmuch as the Commission's proposal, once clarified and enhanced in the manner advocated in TRW's Comments, would enable commercially viable NGSO MSS, GSO/FSS and LMDS systems to operate in the 28 GHz band with only modest constraints, it serves as the best approach to achieving the Commission's goal. The

^{14/} Comments of Hughes at 45-46.

Commission should embrace the reasonable and positive approach put forth by TRW, and approve the band plan it proposed in response to the Third NPRM.^{15/}

DISCUSSION

I. TWO NGSO MSS FEEDER LINK SYSTEMS CAN SHARE SPECTRUM IN THE 29.1 - 29.5 GHZ BAND.

TRW's Comments and a study submitted therewith explain that the 28 GHz band spectrum that the Commission proposes for NGSO MSS feeder link use can accommodate two NGSO MSS systems where one system operates six feeder link earth station complexes (required by LEO system architecture) at 29.1-29.3 GHz for uplinks and 19.4-19.6 GHz for downlinks and the other system operates two feeder link earth station complexes (required by MEO system architecture) at 29.2-29.5 GHz for uplinks and 19.4-19.7 GHz for downlinks.^{16/} TRW's study is consistent with

^{15/} The Commission should not, however, issue a final decision in this proceeding until after it considers the outcome of WRC-95. As many parties, including TRW, explain, a final decision prior to the conclusion of WRC-95 could weaken the U.S. negotiating position at the conference; moreover, its outcome may make the Commission's allocation impractical -- particularly with respect to international systems, which require global uniform spectrum allocations. See Comments of TRW at 33-37; Letter from Douglas Dwyre, President of Loral/QUALCOMM Partnership, L.P., to Hon. Reed E. Hundt, dated September 7, 1995; Comments of Airtouch Communications, Inc. at 2-4; Comments of Constellation Communications, Inc. at 2-3; Comments of Hughes at 26-28; Comments of GE Americom at 20; Comments of Comtech Associates, Inc. at 4 (¶ 6).

^{16/} Comments of TRW at 17-22 and Attachment 1. TRW recently applied for a modification of its authorization (see TRW Inc., 10 FCC Rcd 2263 (Int'l. Bur. (continued...))

the internationally-derived results stated in the CPM Report on Technical, Operational, and Regulatory/Procedural Matters to be Considered by the 1995 World Radiocommunication Conference ("CPM Report"), which concludes that "extensive simulations of frequency sharing between two non-GSO/MSS feeder-link networks in common segments of spectrum at . . . 20/30 GHz bands . . . indicate that frequency sharing between the feeder links of two non-GSO/MSS networks is feasible."^{17/}

Although both the TRW study and the simulation studies underlying the CPM Report took into account the likely characteristics of the Iridium and OdysseyTM^{18/} systems,^{19/} Motorola claims that there is "substantial doubt" as to whether co-frequency sharing "could accommodate . . . the day-to-day operations of more than

^{16/}(...continued)

1995)) whereby it requested, inter alia, that the Commission conditionally authorize it to use the 29.2-29.5 GHz and 19.4-19.7 GHz bands for its NGSO MSS system's feeder links. See Application of TRW Inc. for Modification of Authorization, File No. _____ (filed September 29, 1995).

^{17/} International Telecommunications Union, Radiocommunication Sector, Geneva, 1995 at 51 (¶¶ 3.4.1(c), (d)). To maximize the reliability of its conclusion, the TRW study used the worst case values for EIRP, beam width, and polarization isolation, and used the criteria for acceptable short term interference that were used in the CPM Report and which are acceptable to the OdysseyTM system. See Comments of TRW at Attachment 1: CPM Report at 42 (¶ 3.1.2, Table 8a).

^{18/} "Odyssey" is a trademark of TRW Inc. OdysseyTM is a satellite telecommunications system which is to be comprised of a constellation of twelve satellites in medium earth orbit.

^{19/} See Comments of TRW at Attachment 1 (¶ 1.0); CPM Report at 37 (¶ 1.1) & Table 7.

one MSS system."^{20/} Notably, however, Motorola does not provide any simulation studies, analysis or other data to support its position.

Motorola first criticizes the CPM's extensive simulation studies for being modelled on "very complex in-line interference events between the Iridium system and TRW's Odyssey™ systems . . . [which assume] the existence of large separation distances -- 440 Kilometers in latitude and another 440 Kilometers in longitude -- between feeder link earth stations of the two systems."^{21/} However, since only eight feeder link earth station complex sites need to operate in the U.S. to accommodate two NGSO MSS systems in the 29.1-29.5 GHz band, only two of which would be associated with TRW's Odyssey™ system, the separation distances assumed by the studies are not prohibitive.^{22/} The Commission would need to consider use of the 28 GHz and 19 GHz bands by other NGSO MSS systems' feeder links only if WRC-95 does not yield a suitable allocation in the C band or elsewhere for these other NGSO MSS systems.^{23/}

^{20/} Comments of Motorola at 9-10.

^{21/} Id., at 9.

^{22/} Motorola hopes to identify eight potential feeder link earth station sites, but only operate complexes at six of the sites. Comments of Motorola at 10. TRW requires only two feeder link complexes in the continental United States. Comments of TRW at 19.

^{23/} Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile Satellite Service in the 1610-1626.5/2483.5-2500 MHz Frequency Bands, 9 FCC Rcd 5936, 5998-99 (¶¶ 166, 169) (1994) ("Big LEO Report and Order"). Even then, it is doubtful whether these systems could be redesigned to utilize the Ka-band for their feeder links. Id. at 5999 (¶ 169).

Motorola also contends that because the interference criteria used in the CPM Report were originally developed for the 4-8 GHz band, they "are not necessarily appropriate" for the 19 GHz and 28 GHz bands.^{24/} Motorola however, fails to identify why the criteria may be inappropriate, or justify the criteria it claims to require for its system. The study submitted by TRW assumes that the criteria identified by the CPM are acceptable. In fact, for its own NGSO MSS feeder link system, TRW believes the CPM criteria are acceptable. Motorola, without providing its reasoning or supporting data, continues to insist upon a short-term interference criterion that is an order of magnitude more stringent than the one accepted by TRW. Under these circumstances, the burden is clearly on Motorola to show, if it can, why the interference criteria in the CPM Report are not appropriate for analysis of NGSO MSS-NGSO MSS co-frequency sharing in the 19 GHz and 28 GHz bands.

Next, Motorola's reliance upon a private agreement it entered into with LMDS interests during last year's negotiated rule making proceeding -- to the effect that it could not share the 29.1-29.3 GHz band with another NGSO MSS system^{25/} -- is completely misplaced. Clearly, such a subjective and unsupported assertion cannot counterbalance both the CPM Report and the study submitted by TRW.

^{24/} Comments of Motorola at 9 (emphasis added).

^{25/} See Comments of Motorola at 10 & n.14 (quoting Views of NRMC Members Supporting Motorola-Suite 12/CVNY Rule Proposal In The Form of Their Version of Section VI To Report Of Working Group 2, Report of the LMDS/FSS 28 GHz Band Negotiated Rulemaking Committee ("NRMC Report") at Addenda at 5 (September 23, 1994)).

In addition to criticizing the CPM Report, Motorola ignores the CPM Report's conclusion that "use of bigger gateway antennas . . . could be used to achieve coordination."^{26/} Iridium is designed to use earth station feeder link complex antennas that are only four meters in diameter. Larger antennas clearly are possible, as is demonstrated by the Odyssey™ design's use of earth station feeder complex antennas that are seven meters in diameter. Thus, Motorola may be able to mitigate some of its concern by increasing the size of its feeder link earth station complex antennas.

In the absence of valid criticism of the CPM Report and any meaningful support for opposing co-frequency sharing among NGSO MSS feeder links, and in the face of TRW's showing, Motorola's "uncertainty" concerning such sharing should be rejected. The Commission should confirm its tentative determination that a second NGSO MSS system -- namely, Odyssey™ -- will be permitted to operate its feeder links in the 28 GHz band as a co-primary shared allocation.

II. THE COMMISSION SHOULD ADOPT TRW'S MODEST PROPOSALS TO GOVERN CO-FREQUENCY SHARING BETWEEN NGSO MSS FEEDER LINKS AND GSO/FSS SYSTEMS.

TRW's Comments and a second study submitted therewith offer specific techniques that would be available to facilitate co-frequency sharing between the NGSO MSS and GSO/FSS systems operating in the 29.25-29.5 GHz band while

^{26/} CPM Report at 51 (¶ 3.4.1).

imposing -- at most -- only modest constraints on NGSO MSS and GSO/FSS systems.^{27/} To avoid harmful interference from NGSO MSS feeder link ground stations into GSO/FSS satellite receivers, TRW showed that each NGSO MSS operator with feeder links in the 29.25-29.5 GHz band need only employ one or more of the following techniques where reasonable and necessary: (1) coherently phase its system's orbital constellation and coordinate with GSO/FSS operators as to the placement of GSO/FSS spacecraft; (2) locate its feeder link earth station complexes so as to minimize in-line intersections with GSO/FSS satellites; (3) reduce power levels of its feeder link earth station transmissions; (4) where possible and practicable, switch traffic to an alternate earth station whenever a feeder link earth station is in-line within $\pm 0.5^\circ$ with a GSO/FSS satellite; (5) engage in frequency coordination; and (6) employ polarization isolation.^{28/}

To avoid harmful interference from GSO/FSS ground stations into medium Earth orbit NGSO MSS satellite receivers, TRW showed that GSO/FSS operations in the 29.25-29.50 GHz band need only cease or relocate to another sub-band those earth station transmissions using left-hand circular polarization in geographic zones around the MEO NGSO MSS feeder link stations during those brief periods when the GSO/FSS earth stations are in-line within $\pm 1.5^\circ$ with an associated NGSO MSS

^{27/} See Comments of TRW at 23-28 & Attachment 4.

^{28/} *Id.*, at 24-26. For a system of the medium-Earth orbit design of Odyssey™, it is becoming apparent that site diversity is not practical due to the tremendous geographic separation between the system's feeder link earth station complexes. See *infra*, at n. 34.

satellite.^{29/} The burden to be borne by GSO/FSS under this proposal is minor in terms of the amount of spectrum involved (one polarization on only 25% of the spectrum allocated for GSO/FSS use), duration (only during the exceptionally brief periods when the GSO/FSS earth station is in-line $\pm 1.5^\circ$ with an NGSO MSS satellite), and geography (the relatively modest protection zones surrounding NGSO MSS feeder link earth station complexes, which zones may be further reduced by locating the feeder link complexes near oceans or using larger GSO/FSS earth stations).^{30/} At no time would GSO/FSS systems be precluded from using the 75% of their allocated bandwidth that is not shared with NGSO MSS systems, or from using the shared spectrum anywhere in the United States for right-hand circularly polarized transmissions.^{31/} Indeed, recent TRW studies have shown that with frequency planning that allows pre-assignment of frequencies to specific beams, interference between NGSO MSS feeder links and GSO/FSS service links can be avoided.

^{29/} Comments of TRW at 25-27 & Attachment 4.

^{30/} NASA's Comments support TRW's proposed sharing techniques. See Comments of NASA at 26-27 ("co directional sharing between GSO FSS networks and NGSO MSS feeder links in the . . . [28 GHz and 19 GHz] bands is feasible on both uplinks and downlinks In general, it was found that use of exclusion zones, orbit avoidance, and path diversity are particularly effective mitigation methods to eliminate the identified interference problems").

^{31/} As TRW explained, the sharing structure becomes easier to implement as the size of the GSO/FSS earth stations sharing the band increases. Significantly, at least one of the new filers for a GSO/FSS system at 28 GHz would restrict its earth stations at 29.2-29.5 GHz and 19.4-19.7 GHz to non-VSAT dishes. See Application of Lockheed-Martin Corp. For the Astrolink Communications Satellite System at 51, 74, 97, File No. ____ (filed September 27, 1995).

As TRW explains in this section, its proposal to have modest burdens equitably distributed among both NGSO MSS and GSO/FSS systems sharing the 29.25-29.50 GHz band clearly outweighs all of the more drastic and inequitable suggestions of Motorola, Hughes, GE Americom, and Teledesic.

A. Motorola's Proposal To Ban Completely GSO/FSS Use Of The Shared Spectrum Near NGSO MSS Feeder Link Complexes Is Unnecessary.

Motorola suggests that, in addition to mitigation techniques similar to those proposed by TRW, GSO/FSS operations in the shared spectrum be "restricted to a limited number of large terminals located a substantial distance outside the affected feeder link locations."^{32/} While Motorola's suggestion certainly would reduce the potential for interference, TRW's study shows that complete segmentation is not necessary for a medium Earth orbit ("MEO") NGSO MSS system. Even if Motorola could justify the extremely conservative protection criteria it claims to need, the fact remains that not all NGSO MSS systems are so constrained.

^{32/} Comments of Motorola at 11-12.

B. Hughes's And GE Americom's Suggestions That The Commission Require NGSO MSS Operators To Switch Satellites Or Earth Stations To Avoid Interference Or Change The 28 GHz Band Allocations Are Inequitable And Unnecessary.

Both Hughes and GE Americom suggest that NGSO MSS operators avoid interference with GSO/FSS systems by switching to an alternate satellite or feeder link earth station complex each time interference might occur.^{33/} In other words, Hughes and GE Americom, without providing any justification, contend that if sharing is to occur, the NGSO MSS should bear the entire burden thereof. The burden that would be imposed on NGSO MSS systems under the initial Hughes and GE Americom proposals would require fundamental changes in the design of NGSO MSS systems that are simply too costly to implement.^{34/} Since less drastic and inequitable interference mitigation techniques exist, these initial proposals of potential GSO/FSS operators Hughes and GE Americom -- who would have 750 MHz of

^{33/} Comments of Hughes at 24-26; Comments of GE Americom at 15-16.

^{34/} TRW explained in its Comments that while it is theoretically possible to mitigate interference through the use of alternative NGSO MSS feeder link earth station complexes, the technique is not likely to prove practical. Such a technique has substantial negative ramifications in terms of satellite design, ground station deployment (the technique would require the switching of traffic between earth station complexes that are separated by thousands of miles, and not merely between earth stations in the same complex), and the cost and reliability of network operation. See TRW Comments at 25 n. 41. Accord, Comments of Motorola at Appendix II (p. 3) (under Iridium's current 66 satellite design, when an in-line event occurs there may be "no other Iridium satellite in view to accept traffic from the gateway").

exclusive primary spectrum at 28 GHz and 1000 MHz at 19 GHz -- should be rejected as unreasonable and entirely unnecessary.^{35/}

Hughes proposed two other "solutions," in which co-frequency operation between NGSO MSS and GSO/FSS would be entirely avoided. Hughes first proposed to allocate only 150 MHz of the 28 GHz band for NGSO MSS (at 29.1-29.25 GHz) and eliminate NGSO MSS from the 29.25 - 29.50 GHz band entirely.^{36/} By providing only 150 MHz of spectrum for NGSO MSS, this solution would effectively exclude NGSO MSS feeder links for high-capacity satellites from the 28 GHz band.^{37/} In addition, Hughes's "solution" would require one of the two NGSO MSS systems that could be accommodated in the 28 GHz band under the

^{35/} In support of its proposal, Hughes cites to its Comments and reply Comments in another proceeding, Preparation for ITU World Radiocommunication Conferences (IC Docket 94-31) and a Hughes ex parte presentation in the proceeding at hand. See Hughes Comments at 25 (n.22). Notably, Hughes argues in its Comments and Reply Comments in IC Docket 94-31 that if sharing criteria are established, NGSO MSS feeder links can share spectrum with GSO/FSS. Specifically, Hughes's Comments and Reply Comments advocate "path diversity" (i.e., shifting MSS traffic to another satellite or earth station). However, Hughes also noted that its own studies show that interference also can be reduced by means of exclusion zones, carrier frequency offsets that still yield some frequency overlap and efficient frequency reuse and polarization discrimination. See Comments of Hughes, IC Docket 94-31 at 8 (Filed March 6, 1995).

^{36/} Comments of Hughes at 20.

^{37/} For example, Iridium's feeder links require 200 MHz and Odyssey's require 300 MHz. Third NPRM, FCC 95-287, slip op. at ¶ 59.

Commission's proposal to operate uplinks in the 19 GHz band on a "reverse band" basis.^{38/}

This proposed "solution" is completely unacceptable to TRW. The spirit of compromise that underlies both the band segmentation proposal detailed in the Commission's Third NPRM and the accommodation TRW proposed in its Comments are demeaned by this suggestion, which serves only Hughes's pecuniary interests. Substantively, TRW has shown that the use of the 19.4-19.7 GHz band on a reverse-band working basis imposes unacceptable cost and schedule penalties on the OdysseyTM program,^{39/} and it remains uncertain in any event whether the international spectrum actions required to enable the use both of the 19.4-19.7 GHz band in an Earth-to-space direction and of a suitable paired downlink band will be approved at WRC-95. Furthermore, the CPM Report questions the feasibility of reverse-band working on a co-frequency basis with GSO/FSS and fixed service systems. TRW has also demonstrated that it can share generally with GSO/FSS systems in the 29.2-29.5 GHz band, and with Hughes's proposed "Spaceway" system in particular. Therefore, Hughes's first solution must be rejected.

Hughes's second proposed "solution" is comprised of a complete restructuring of the Commission's band segmentation plan in accordance with a scheme Hughes and several others submitted to the Commission early in the process.^{41/} Under this

^{38/} Comments of Hughes at 20.

^{39/} See, e.g., Comments of TRW at 10 n.11.

^{41/} See Comments of Hughes at 23.

plan, NGSO MSS feeder links and LMDS would share 500 MHz of spectrum on a co-primary basis (at 29.0-29.5 GHz), and the primary allocation proposed for LMDS at 27.5-28.35 GHz would be cut back to 500 MHz (at 27.5-28.0 GHz). The NGSO/FSS would retain a 500 MHz primary allocation (albeit one that does not match the U.S. proposals for WRC-95), and the GSO/FSS would receive the 1000 MHz primary allocation originally requested by Hughes.^{42/}

TRW does not believe that it will be necessary for the Commission to cause the disruptions and delays that will inevitably result from the dramatic recasting of the band plan that Hughes suggested.^{43/} Indeed, as a result of ongoing discussions between Hughes and TRW, TRW is confident that agreement can be reached that co-

^{42/} The completely unsupported suggestion of GE Americom that NGSO MSS systems be relocated out of spectrum desired by GSO/FSS systems must be rejected. See Comments of GE Americom at 14. GE Americom couples this suggestion with a proposal that LMDS be relocated to 40 GHz. The band plan proposed in the Third NPRM represents a compromise that is not perfect, but that is designed to facilitate the rapid introduction of the involved services. Licensees such as TRW are poised to commence service in the very near future, and their interests should not be held hostage to the whims of other entities that are at a much earlier point in the authorization curve and can therefore withstand the impact of suggestions that would delay establishment of any system by a number of years.

^{43/} Assuming that the same rules would apply to LMDS/NGSO MSS spectrum at 29.0-29.5 GHz that are now proposed for 29.1-29.25 GHz, TRW suspects that the LMDS proponents will generally be unwilling to accept in 500 MHz (i.e., one half of their allocation) the curtailed availability of spectrum for subscriber-to-hub transmissions and the limitations -- modest as they may be -- that are imposed by the existence of up to eight NGSO MSS feeder link earth station complexes in the United States.

frequency sharing between NGSO MSS and GSO/FSS systems is feasible and practical.

Again, TRW emphasizes its belief -- backed up fully by its sharing study -- that an NGSO MEO MSS system such as Odyssey™ can share spectrum at 29.2-29.5 GHz with multiple GSO/FSS systems (and not just with Hughes's Spaceway system) through an equitable employment of modest interference mitigation techniques. It encourages the Commission to proceed with the adoption of the band segmentation plan proposed in the Third NPRM, as modified in the manner suggested in TRW's Comments.

C. The Concerns Of Potential GSO/FSS Operators About Procedures For Coordination With NGSO MSS Feeder Link Systems Are Unfounded.

In its Comments, Hughes expresses concern over the Commission's proposal to implement coordination between GSO/FSS systems and NGSO MSS feeder link earth stations in the same band on a first-come-first-served basis.^{44/} Hughes believes this method could foreclose GSO/FSS use of the shared spectrum over large portions of the U.S. unless standards are implemented to facilitate sharing between NGSO MSS feeder links and GSO/FSS systems in the shared band.^{45/} Hughes adds that even with sharing standards, GSO/FSS systems may be precluded from using the shared

^{44/} See Third NPRM, FCC 95-287, slip op. at ¶ 64.

^{45/} Comments of Hughes at 3, 12.